Operators Manual
Projects for Elysa Carlson

Zip Line Walking Device, Water Bike, Stationary Bike, Adaptive Skiing Device, and Saddle Eating Chair

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Important Safety Information:

Zip Line Walking Device

- Do not shift weight excessively to prevent accidental tipping
- Always make sure all of the clips and carabiners are correctly in place
- Make sure the nuts that are screwed on the eyes are secure
- Inspect all parts of device for signs of damage and wear before and after each use
- Harness [1]:
    - Improper use may cause serious injury or damage
    - Maximum weight capacity is 40kg (104lbs)
    - Do not store in damp air as it can cause the buckles to corrode and damage the harness
    - Do NOT store in light as there is an aging effect which gradually reduces the strength of the webbing
    - Do NOT use if it has any defects, broken stitching, cracks, damages, abrasion, corrosion
- Carabiners [2]:
    - Must not come into contact with corrosive materials such as battery acid, battery fumes, solvents, chlorine bleach, antifreezes, isopropyl alcohol, or gasoline
    - Factors that can reduce the lifespan: Falls, abrasion, wear, prolonged exposure to sunlight
- Adjustable straps:
    - When adjusting the height of the harness, make sure to re-buckle it to make sure that it is secure and does not loosen while in use
- Adjustable Bungee Cords [3]:
    - Clips should be attached to allow the clip gates to fully close – do not attach the clips by the tip, or in any manner that would not allow the gates to fully close
    - Stretch cord carefully, keeping body away from out of the path of possible rebound.
    - Do not pull cords toward or away from yourself or another person.
    - Do NOT stretch cord more than 50% of its original length. Over stretching cord can cause hook or cord failure resulting in uncontrolled release.
        - Can cause severe injury to unprotected body parts, especially eyes.
    - Keep out of reach of children.

Adaptive Skiing Device

- This product is meant for backyard use only.
- Never use the skiing device on the hills or steep incline
- This product should be stored indoor when not in use
- Armrests, harness, and outdoor canvas have to be taken off and stored in dried place when not in use
- This product is designed to carry only **ONE** passenger at a time

- The weight limit is less than 40 lb
- Make sure the quick-released button connectors “click” every time when the height is adjusted
- This product requires adult supervision at all time
- This product should not be ridden without safety harness
- Make sure the straps on the bindings are tied around the feet when in use
- This product should be picked up evenly on both sides

Saddle Eating Chair

- Make sure this product is used on a level surface to prevent tipping
- Ensure the child Is securely attached
- Ensure no rips or tears are forming in the harness or attachments
- Make sure all pins are in place and locked firmly
- Parental supervision at all times
- Never place child in the chair without wearing harness and being secured to the chair by attachedments

Stationary Bike

-
- Make sure all wires are not under foot to prevent tripping.
- Carefully handle the LED light display it is glass and can break
- Never spill water on or near the light display it is not water proof
- Make sure child is securely belted in before use
- Parental supervision at all times
- Always use safety harness

Water Bike

Safety is extremely important when using the water bike. It will be used in a local pool and any activity for Elysa in a body of water adds an aspect of danger. As long as the bike is used properly the Elysa should be in no danger at all.

- Recommended that Elysa have constant supervision when using the bike
- Recommended that an adult be in the water close to Elysa at all times
- After any repairs are made, test device before letting Elysa use it again
- If any repairs are needed (i.e. A crack or loose tube) and has yet to be fixed, Elysa should not use the bike
    - If the bike were in the water with a crack or loose fit, it could fill up with water and sink to the bottom of the pool
    - This would pose an obvious problem if Elysa was on the bike.

Parts and Accessories:

Zip Line Walking Device

- Overall Device (replace w/one without Elysa)

- Aluminum Strut Channels (x2)

- Trolley with Eyebolt

- Cable Clamps

- Turnbuckle

- Carabiners

- Nylon rope with Wire Core and Connections with Carabiners, Turnbuckle, Thimble, and Cable Clamps to the Trolley Eye bolt

- Pulley with Swivel

- Steel Eye Bolts

- Adjustable Bungee Cords

- Strap with Buckle

- Harness

- Whole Harness Structure

Adaptive Skiing Device

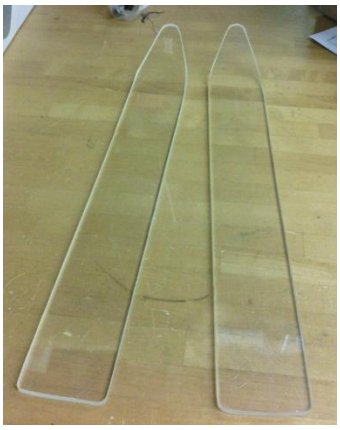
- Back support

- Outdoor canvas for back support

- Armrests

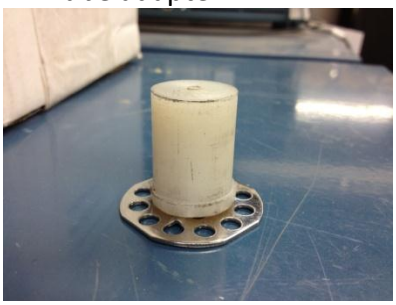
- Outriggers

- Plexiglas skis



- Reinforced bar for outriggers

- Tube adapter



- Skis + Bindings

- Corner braces

Saddle Eating Chair
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Stationary Bike
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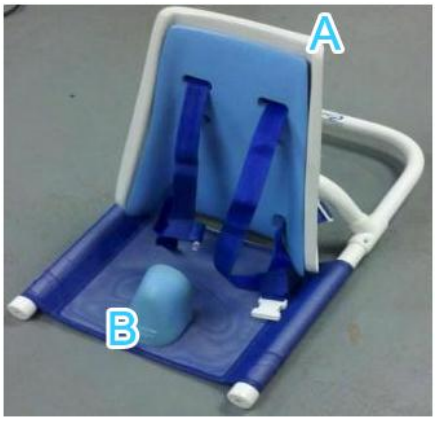
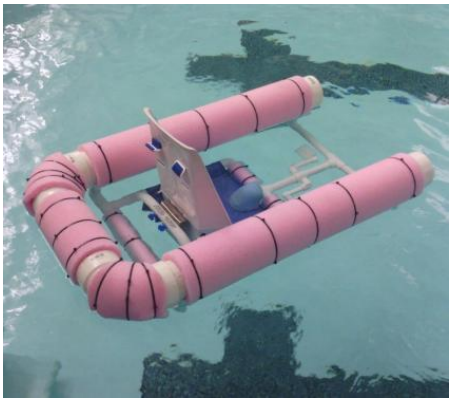
Water Bike

- Chair



- Adjustable Backrest (A)
- Pommel (B)
- PVC Frame



  - 1”PVC tubes

- Elbow connectors

- T connectors

- “U” Support Tubes

- 4 ½” PVC Tubes

- Elbow Connectors

- End Caps

- PVC Cement

- Pedals
    - ¾” PVC Tubes
    - End Caps
    - Elbow Bracket
    - Plastic Petals
    - Velcro

- Close Cell Polyurethane Foam

- Pourable Expanding Polyurethane Foam

Features:

Zip Line Walking Device

- Adjustable straps to adjust the height of the harness
- Turnbuckle to adjust the tension of the zip line
- Easy to assemble/disassemble via carabiners

Adaptive Skiing Device

- Aluminum structure
    - Light weight, strong, good corrosion resistance
- Adjustable/removable armrests and back support
    - Custom-design for Elysa
- Outriggers
    - Custom-made for safety purpose

Saddle Eating Chair

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Stationary Bike

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Water Bike

- Straps are attached to the backrest
    - Optional feature because they are not necessary to keep Elysa in the bike
        - If she is struggling to stay in place, they can be used
    - Remove the straps immediately if a leak appears
        - To keep Elysa from being pulled under as the bike sinks

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1. Introduction:

1.1 - General Overview

Zip Line Walking Device

Examining the device as a whole, the device is pretty simple. At a first glance, one of the most important aspects of the device is the zip line itself, which is essential for the device to come together. The zip line in this application is used essentially as a guide wire for Elysa as she is walking across the room, as well as being the support system keeping the harness structure in place as the pulley rolls along the zip line. Figure 1 below is a picture of the general device.

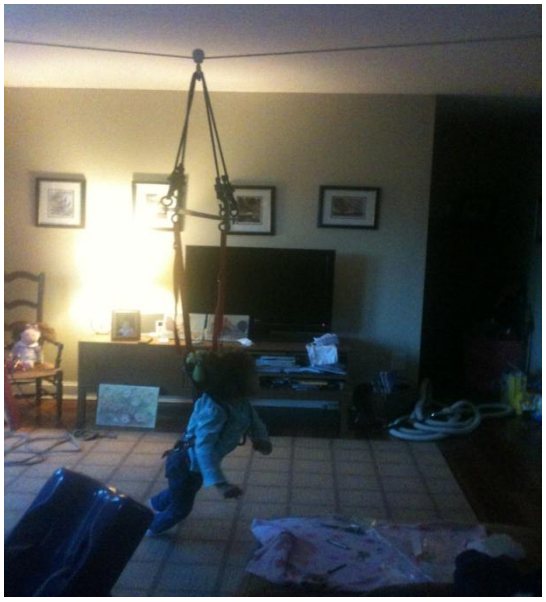


Figure 1: Zip Line Walking Device as a Whole

Next are the connections that the rope has to the walls above the two entryways of the room, as seen in Figure 2. The rope is tied off by cable clamps and a thimble where the rope folds over. Knots are not ideal for this application and would be difficult to do anyway because of the wire core. One end of the rope is connected to a turnbuckle by a carabiner, which is connected to another carabiner to the eye bolt of the trolley.

Figure 2: Connections for the Zip Line

The other end is simply just connected to the other eyebolt in the trolley with a carabiner. The trolley's wheels roll within the strut channel so that they do not fall out as they

are moving along the track. The aluminum strut channel is 8’ long and there is one screwed into the walls of the two entryways across the room. The strut channel provides a place for the trolley to move through, and combined with the parts of the zip, put the device together.

The harness structure is what connects the zip line to the rest of the device. At the top, is a pulley with a swivel. The pulley portion is what moves along the rope as Elysa is walking across the room, while the swivel provides the rotating dynamic, and connects to the rest of the device. Right below that is a cable clamp that is connected to a set of adjustable bungee cords, which are in a crisscross pattern and the clips at each end are clipped to the four steel eyebolts at each of the four corners of the aluminum plate.

Figure 3: Harness Structure at Carlson’s House

Figure 4: Built Harness Structure

The two figures above, Figures 3 and 4, is the harness structure section as a whole. Moving down, are two additional steel eye bolts, which connect to a set of carabiners. From there, are the two adjustable straps with buckles, which add additional length for the structure as whole, as well as adjusting the height of the harness.

Adaptive Skiing Device

The primary purpose of this device is to allow our client, Elysa, to extend her activities to outside of the house. Her parents want her to be able to stand on the ski on her own with minimum support; therefore she can enjoy the freedom and independence when skiing down the hill. The other purpose is to teach Elysa the proper stance of skiing.

The back support consists of the aluminum structure, outdoor canvas, and safety harness to hold Elysa in place while standing on the device. It is located at the back of the device. Since we provide one harness that can be used for all her devices, she can put on the harness before standing on the skiing device. The safety harness prevents her from falling off the device. The structure of the back support is shown in Figure 5.

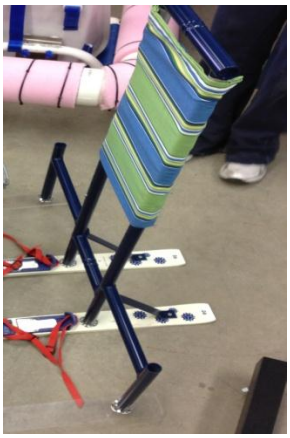


Figure 5: Structure for back support

The armrests are located in front of the back support and they allow Elysa to put her arms on it for balance, and the straps on the arm rests can also provide support to hold her in place, shown in Figure 6.

Figure 6: Armrests

The straps on the bindings are located on the skis, and they are used to hold her feet in place while operating the device. It is important to put on the strap otherwise she might slip off the device when it starts moving. The bindings and straps are shown in Figure 7.

Figure 7: Straps and the bindings on the skis

The outriggers are located on each side of the back support and armrests; they prevent the skiing device from tipping to the sides while riding it, shown in Figure 8.

Figure 8: Outriggers

Saddle Eating Chair

This device has few components. It consists of a base, seat post, seat and back support.

The base is a simple design with locking caster wheels attached underneath to make it mobile.

The telescoping tubing is square aluminum tubing. Holes are drilled in it with pins that fit exactly in these holes to lock it at different heights.

Semi-circle discs with pin holes allow the seat post to tilt and make the attachment to the base very secure. The seat post rotates on a wing nut that keeps the seat post firmly attached while the seat post is adjusted. All components can be seen below.

Stationary Bike

The primary components are a Schwinn model A20 recumbent bicycle. Our modifications are shown above. One can look at the pedal and see the white plastic wedge that was attached to the wheel to reduce the distance our client has to reach when pedaling. Also the additional back pad is shown with harness attachment.

The above picture of the bike did not include this RGB LED display. It consists of the frosted glass lamp shade. Contained inside this shade is the light pictured below

This light has several different settings. The light will flash between different colors or slowly blend between colors. Finally the light can respond to music played. The light can be dimmed as well as any color available on the remote control can be chosen. All the settings are controlled through the remote so the client's parents can be involved.

The harness and seat are attached using the car hook up for the harness. A detailed view is shown below

Water Bike

Figure 9: Overall Structure

The water bike is designed to give Elysa the chance for an enjoyable for of Hydro-physical therapy. The Carlson family often visits the local pool and expressed a desire for Elysa to have some device she could use to make this time not only fun for Elysa but also productive. We decided on a recumbent bike that would be partially submerged in the water and would work similarly to the stationary bike in the Carlson living room. The design for the bike is actually very simple. A large "U" shaped barrel is the main source of support for the entire device. The 4 ½" tubes, which are surrounded by another inch of closed cell polyurethane foam

offer enough buoyancy to keep both the bike and Elysa afloat in the pool. Figure 9 above shows the whole device.

This is what keeps the entire structure rigid. The rest of the frame and the seat are connected to these tubes and remaining firmly in place because of it. The rest of the frame is built from 1 ½" PVC tubing and connections are made using rubber cement. There are some areas of the frame which have openings and allow for water to seep into (ie. where the pedals and back support are connected). These areas are sealed off from the rest of the frame with the use of pourable expanding polyurethane foam. This is the same material used to fill the hull of smaller boats.

Figure 10: Seat

The seat, as seen in Figure 10, which can be seen above was purchased from the NEAT Marketplace in Hartford. It was a refurbished bathing chair that we adapted to fit our device. The back support is height adjustable and is made from plastic with a waterproof foam pad. There are straps available for Elysa to keep her restrained however these are not necessary for use. There is a pommel in place to keep her back in the chair which composed of a rubber material. The bottom of the seat is mesh material with a piece of plastic sewn in for added support.

The pedals again were built from PVC piping. This time they are ¾" in diameter. The pipes are connected in a zigzag fashion that extends through the center connection of the frame. The pedals are made of plastic and were milled to fit Elysa's foot size. They are connected to the PVC pipes with a circular pin through both the pedals and pipe. This allows for free rotation as the pedal unit turns. Also attached to the pedals are Velcro straps that will be used to keep Elysa's feet in place while she is using the device.

It should be noted that this bike is never to be used without supervision. Elysa should be watched at all times when on the bike and it is recommended an adult is within arm's length of Elysa in case any sort of problem arises.

1.2: Step by Step Instructions to Use the Devices

Zip Line Walking Device

By following the instructions below, one can easily use this device without too much difficulty. Note that the harness structure is already connected to the swivel on the pulley by the cable clamp on the bungee cords. This is because we connected those parts together before we put the cable clamps and thimbles on the two ends of the zip line

1.2.1a. the first step of using the device is to check on each of the components to make sure that they are in operating condition. Like in Figure 13, which shows the things that are not suitable for the carabiner, Figure 11 shows several things that one should check on before using them to connect the rest of the device.

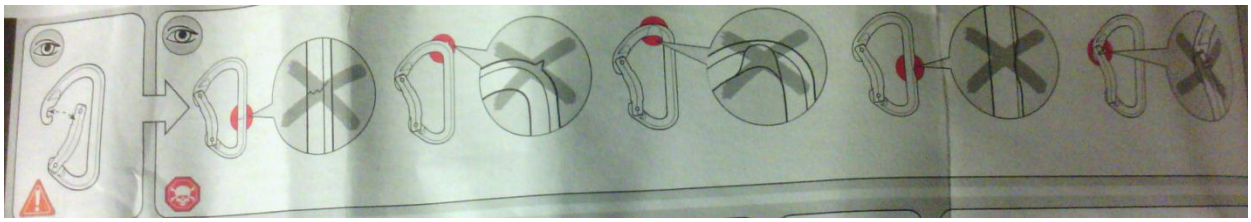


Figure 11: Inspecting Carabiners for Any Kind of Defect

1.2.2a. Once all of the components are checked and are deemed useable, it is time to connect the carabiners through the eyebolts of the trolleys to the two ends of the zip line, which remember that one end has the turnbuckle attached to it, which can been seen in Figure 12 below.

Figure 12: Carabiner Connections to the Zip Line

Keep in mind that one has to make sure that the carabiner is connected securely to the eye bolt of the turnbuckle and loop on the other end, which also applies when the carabiners are attached to the trolley eyebolt. Figure 13 below is directly from the safety instructions that came with the carabiners.

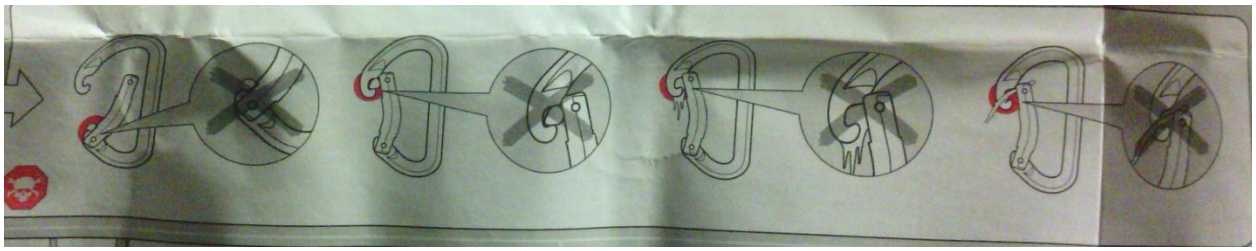


Figure 13: Safety Directions for Carabiner

These are things that one does not want to occur because if they do, they can cause the device to fall apart, which can possibly cause injury for Elysa. This is something we want to avoid happening, so while it will take a few extra minutes to double check everything, it is better to be safe than sorry.

1.2.3a: Once the zip line is together and connected to the trolley eyebolts, the remaining carabiners can be used to connect the harness to the structure. This is achieved by putting the carabiners through the two eye bolts that are on the bottom of the aluminum plate, threading the straps (one per carabiner) through each carabiner then connecting to the harness through the shoulder straps. Once this is done, the straps can then be adjusted to the desired height. Keep in mind that when one is adjusting the straps, it is important to re-buckle the strap, as shown in Figure 14.

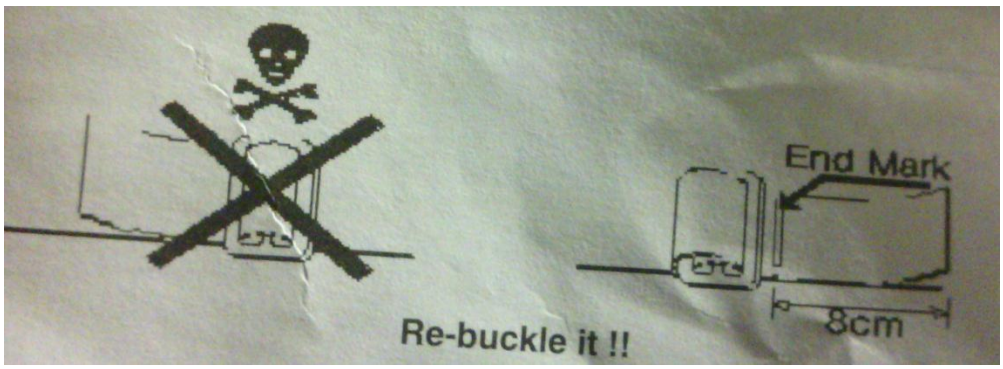


Figure 14: How to Re-Buckle the Strap

The figure is from the user manual for the harness, but it can apply to the adjustable straps as well. This is so that the strap will not come undone while the device is in use. After this, the user can be placed into the harness and use the device as desired.

1.2.4a. Once the user is done using the device, the device can be disassembled, following steps 1.2.1a – 1.2.4a in reverse order, beginning with taking the user out of the harness. Once the device is disassembled, store the parts in a dark, dry place. This will give the longest possible life span for the device as a whole.

Adaptive Skiing Device

1.2.1b. Before operating the device, make sure all the parts are securely assembled to the structures; there shouldn't be any part loosing or wobbling. Check and make sure the pin and screws aren't loosening. The entire device must be assembled before the rider is placed on the skis. Make sure the armrests and the back support are at the appropriate height for the rider. The rider must put on the safety harness before standing on the skis. Once the device is adjusted, the rider can now be placed on the device.

1.2.2b. Make sure the device is placed on the flat surface before placing the rider on it. While the rider is on the device, make sure the safety harness on the rider is attached to the carabiners on the back support so the rider is fixed in position. The rider should put his/her feet on the bindings and use the straps to secure the feet. The rider has to put his/her arms on the armrests and the straps should firmly tie the arms to the soft pads. The rider can hold on to the grips if he/she wants to. The rider should feel comfortable in this position, if not, adjust the armrests to appropriate height until the rider feels comfortable. The device is meant to be operated and under supervision by another person, so make sure there is at least ONE adult operating the device. The operator is required to hold on to the device at all time, since the device is not operatable by the rider. The device is not meant to be ridden on the hill or steep slope.

1.2.3b. Make sure the device comes to full stop when the rider is getting off. The armrests straps should be unfasten first, then the binding. The connection on the carabiners of the back support should come off last. After the rider gets off the device, the device has to be stored indoor when not in use. The armrests and the outdoor canvas should be taken off from the device and dried before storing them. Armrests and outdoor canvas should be stored in dry place to prevent mold. The device can be disassembled if it is easier for storage.

1.2.4 Saddle Eating Chair

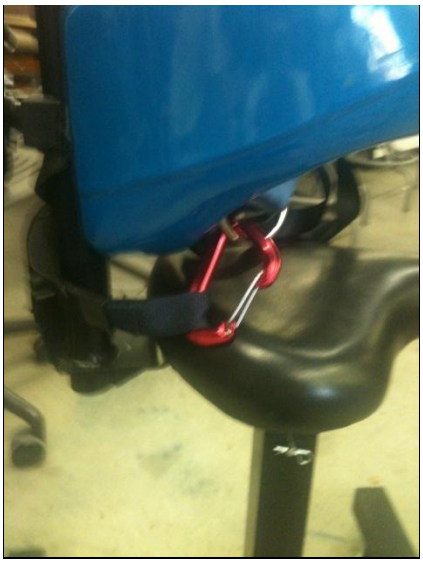
This is very simple to use. To adjust the height the telescoping tubing can extend or retract to whatever height desired. It will be held at that height by the clevis pin. The telescoping section and tubes can be seen below. Make sure the locking section of the pin is in place so the pin cannot slip out.

The chair can be tilted by removing the top clevis pin on the base that is shown in the picture above. Then tilt the chair to the desired position and replace clevis pin through holes, again making sure to place the locking section at the end of the pin so the pin cannot slip out.

Once the height and seat tilt are set the operator will use the locking mechanism on the wheels to ensure the chair won't move while placing the child in the chair

Fit the EZ on adjustable harness to the child prior to trying to put them into the chair.

Once in the chair make sure to attach the shoulder straps as shown below as well as the waist attachment for the harness to ensure safety of the child. Make sure attachments are secure and all carabiners are completely closed.



Once the child is safely attached in the chair the chair can be moved but the user must be careful to keep it on a flat surface so it doesn't tip.

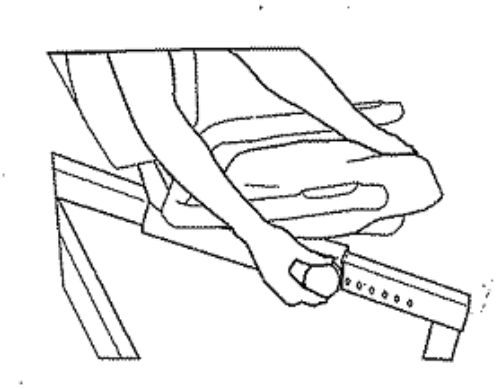
Never change the seat height or the tilt of the chair while the child is in the seat.

1.2.5 Stationary Bike

Included in the owner's manual provided by the company are all the directions for the different exercise programs and specific features. These are not important for basic operation and can be referenced in the original manual that will be available.

Start by pressing the start button on the console. This will start the machine. The buttons that control the resistance are located on the console as well. Simply press the desired resistance up or down.

To select seat position on the track. Turn the knob pictured below to loosen it and pull outward, Slide chair as desired along track to select seat position. Release the knob and let it lock into one of the holes in the side. Once the knob is in place turn the knob in the opposite direction to tighten it to secure the chair in place.



Now place the user in the seat. Again Place the child in the EZ on adjustable vest prior to placing her in the seat. The attachments for the shoulder and waist are pictured below. Simply clip them on and they are securely in place

Next place the user's feet in the foot pedal and place the strap over it fit it snuggly to ensure the foot stays on the pedal while operating.

Water Bike

1.2.1e. Place the boat directly in the water near the edge or in the shallow end of the pool. Place Elysa in the chair so she is comfortable with a leg on either side of the pommel (she should be wearing her personal floatation device). The straps on the chair are optional for use.

1.2.2e. When Elysa is comfortable strap her feet into the pedals by adjusting the size of the Velcro straps. Once she is comfortable and her feet are properly strapped, she can begin to pedal the bike which will remain in place unless moved around by an outside force as requested per the Carlson's. The front of the bike was left open from the support barrels for a reason. This is an area where someone (Elysa's parents) to stand and help guide Elysa through the proper

pedaling motion. This is meant to create a form of coordination that will translate back to the stationary device in the Carlson home.

2. Maintenance:

A main goal of constructing these devices was to keep maintenance to a minimum. In order to do that, there are little to no electrical components, and the overall design was kept simplistic to allow for maximum functionality with minimum complexity. Therefore, any maintenance necessary to maintain each of the devices is simple to carry out.

Zip Line Walking Device

2.1. Mechanical

2.1.1. Zip Line, Turnbuckle, Cable Clamps, Thimble

These components are connected and stay connected, unless desired otherwise when the device is not in use. Like the rest of the metal components, besides the zip line itself, since the device is only an indoors application, corrosion is not a huge concern. Despite this, it is still a good idea to check the components for any signs of corrosion. For all the components, make sure to check before and after use for signs of wear, cracks, or any other possible defects that could cause a problem down the line if the device is not maintained properly. Store parts together in a dry place.

2.1.2. Harness [1]

Before and after each use, check the device to make sure that it is still useable. If necessary, wash with mild soap and warm water. (maximum 40°C/104°F) Clean it well then let it dry in a dark place. Keep it away from sunlight and chemical reagents as these things can shorten the lifespan of the device. At high temperatures above 80C° (176°F), this can shorten its lifespan. With chemical reagents, such as with strong acids, can corrode the webbing and buckle. Both effects can make the harness unusable or unsafe. With storing the harness, do NOT store it in damp air. The damp air can corrode the buckle, which will damage the harness. If it is stored in the light, there is an aging effect that will gradually weaken the webbing.

2.1.3. Aluminum Strut Channel

As this device is installed indoors, corrosion from the elements is not a concern, and the component is minimal. The only maintenance needed is to check if the channels are still securely in place before and after each use.

2.1.4. Carabiners

The carabiners are quite important in this device since they are needed to connect the components together. In that aspect, it is important to make sure that they are in proper working order before and after each use. Falls, abrasion, wear, prolonged exposure to sunlight can shorten the lifespan of the carabiner. It also must not come into contact with corrosive materials such as battery acid, battery fumes, solvents, chlorine bleach, antifreezes, isopropyl alcohol, or gasoline. These things can also shorten the lifespan.

2.1.5. Adjustable Straps

Like with the harness, only wash it as necessary and in warm water with mild soap. Also when storing the straps, do not expose them to prolonged sunlight as this can weaken the straps over time, which could cause them to snap during use if not caught early. Store them in a dry, dark place to keep them in staying in good condition.

2.1.6. Harness Structure

Maintenance is minimal. See care in 2.2.1.

Adaptive Skiing Device

2.2. Mechanical

2.2.1 Aluminum structure:

The aluminum structure should be checked for scratches and chipped paints occasionally to prevent rusting. It has to be cleaned and dried each time after use. Dents should be checked regularly as it might affect the sliding of the telescoping tubes when adjusting the heights. The screws and pins on the structure have to be checked regularly to make sure they are not rusting.

2.2.2 Outdoor canvas:

The outdoor canvas has to be stored in damped air when not in use at all time to prevent molds. Since the outdoor canvas is removable, it can be cleaned regularly. The outdoor canvas can be cleaned using washing machine or by hand, and let dry completely and store in dry place. Check the Velcro on the outdoor canvas regularly to make sure it is not loose and functioning well.

2.2.3 Armrests:

The armrests are also removable, so they can be stored in dry place when not in use. The armrests have to be cleaned and dried after use every time to prevent molding. The soft pad and the straps can be removed separately and cleaned. They can be cleaned either by hand or with the washing machine.

2.2.4 Outriggers:

The Plexiglas skis have to be checked for crack regularly for maximum safety. Make sure there is not dent or bending on the Plexiglas skis. They have to be dried off and cleaned after each use to prevent the screws from rusting.

Saddle Eating Chair

This device requires very little maintenance as long as it is kept indoors.

2.3.1 Aluminum frame:

Keep it clean if anything is spilled on it and try to prevent scratches to keep the paint from chipping in any way. Keep the frame and seat dry. Do not use harsh chemicals to clean.

Wheels:

If they become loose tighten the bolts.

Straps:

If the straps get ripped or torn replace them immediately.

Stationary Bike

2.4.1 Mechanical:

If the straps or clips break replace them. Make sure all screws and bolts are tightened and check this every 2 months.

2.4.2 Electrical:

Replace batteries as needed. To replace batteries remove cove on the back of the console and take out the old batteries and replace with new ones. Replace LED light bulb as needed. To replace LED light bulb loosen the screws that hold the metal attachments in place. Remove the frosted glass shade. Unscrew the light bulb. Replace with new light bulb. Replace the frosted glass shade to the attachments. Tighten the screws and make sure the shade is securely in place.

Water Bike

2.5: Mechanical

2.5.1 Storage

It is important to properly maintain the water bike to prevent problems from arising in the future. If the bike is not maintained it could form leaks and end up at the bottom of a pool. The bike is entirely waterproof and should not be affected by any of the chemicals in the pool. However, it is advisable to allow the bike to dry before storage. This is important to prevent the growth of any bacteria on the surface of the bike that could prove hazardous to Elysa's health.

2.5.2: Metal Pins

Pay close attention to the metal pins connecting the pedals when allowing the bike to dry. This is the area most susceptible to corrosion.

2.5.3: Bike Frame

It is important to keep a look out for bubble floating to the surface while the bike is in the water. The bike is currently air tight and has no leaks but it is not guaranteed that after repeated use especially after vigorous use the seals will all last forever. A rubber cement will be provided with the bike that can be used to re-seal any areas that have loosened over time. See the instructions listed under the troubleshooting section for how to fix any loose parts.

3. Technical Description

Zip Line Walking Device

3.1.1: Track System

The track component of the device is made up of the aluminum strut channels and the trolley with accompanying eyebolt. For the aluminum strut channels, we originally thought that we were going to paint the tracks to match our client's wall color

and blend in. However, when Elysa and her parents came by to visit and saw the strut channels in person, they said that they did not mind the unfinished metal, as seen in Figure 15. In fact, they said that keeping them as is would give them options if they were to repaint their room, rather than needing to match the color of the track.

Figure 15: Aluminum Slotted-Hole Strut Channel

The wheels of the trolley are inside the track, which the enclosed track will prevent the wheels from falling off as they roll within the track. The trolleys, shown below in Figure 16 one in each channel, are made of zinc-plated steel. Each of them has a horizontal plate with a 3/4" diameter eyebolt. This will provide a sufficient place for a carabiner and zip line to attach to.

Figure 16: Zinc-Coated Steel Trolley for Strut Channel

This trolley has worked out well as it goes along with the track. The only problem that we've had with it is that the metal to metal contact that the trolley has with the strut channel, which has caused a lot of friction. This is because we have the strut channel on its side – the slotted holes facing towards the wall, to make screwing bolts into the wall easier. If we had used the channels in their original orientation, there would be a lot less friction and drag from the metal-to-metal contact.

3.1.2: Zip Line Cable

Instead of using the aforementioned galvanized zip line cable mentioned in the Optimal Design, we are now using a ¼" nylon rope with wire core for added strength, as seen in Figure 17. This rope is a lot lighter than the galvanized zip line cable and while it is not as strong as the cable, the wire core does add additional strength, and is still flexible. It was not necessary to have such a thick cable, which also was quite bulky for our purposes. It will span the width of the room (13' ½"), but there will be around two feet of extra cable to allow it to be tied off. Traditional knots are not ideal for this application as they can come apart if not tied properly, as well as the wire core making the rope stiffer than a regular rope. To accomplish this, cable clamps, seen in Figure 18, also known as wire rope clips, are use to tie off the cable.

Figure 17: Nylon Rope with Wire Core

Figure 18: Galvanized Cable Clamp

Figure 19: Thimble

The cable is folded around a device called a thimble, as seen in Figure 19. These prevent the cable from crimping and protecting it from wearing at the anchor points. Once around the thimble, three cable clamps are clamped onto the cable. More than three cable clamps can be used to tie off cable. However, three clamps is the minimal amount of clips needed to tie of the cable. Usually three to four clamps are used in normal applications, but more can be used if there is an extra excess of cable. Figure 20 shows their connections to the strut channel. Also in this figure is a turnbuckle, which is used to adjust the tension of the zip line.

Figure 20: Turnbuckle and Zip Line & Connections

3.1.3: Attachment Connectors

To connect the zip line to the eye bolt, a carabiner will be used, as seen in Figure 21. Carabiners have many applications, but for this device, they provide the connection between the zip line, trolley/pulley, and harness.

Figure 21: Non-Locking Carabiner

3.1.4: Trolley and Rotating Dynamic

A swivel is used to add a rotating dynamic when one is riding a zip line. In this case, we are using the swivel to allow Elysa to turn around and walk back in the direction that she just came from. For the prototype, instead of using an actual zip line trolley, like in the Optimal Design, we decided to use the pulley that is in Figure 22 below.

Figure 22: Pulley and Swivel

This pulley also comes with a swivel which actually rotates with a lot less resistance than the original swivel, which would make it much easier for Elysa to rotate. The only problem we had with the swivel was that a carabiner is not able to fit through the hold, let alone the bungee cords. We solved this problem by using a cable clamp to go through the hole and keep the cords in place.

3.1.5: Harness Structure

Figure 25 shows a picture of what the built harness structure looks like. The harness structure is a rectangle plate of aluminum that is 10” x 3” x 1/8” (L x W x H). On the top and bottom of the block, there will be several steel eye bolts, as shown in Figure 23.

Figure 23: Steel Eye Bolt

There are four on the top – one at each corner, and two on the bottom – toward the center of the plate. The top four eye bolts are connected to the clips of the adjustable bungee cords, while the bottom two eye bolts will be connected to the straps that are connecting to the harness. Figures 24 and 25 below show the whole harness structure together with the harness, as well as the original Visio drawing.

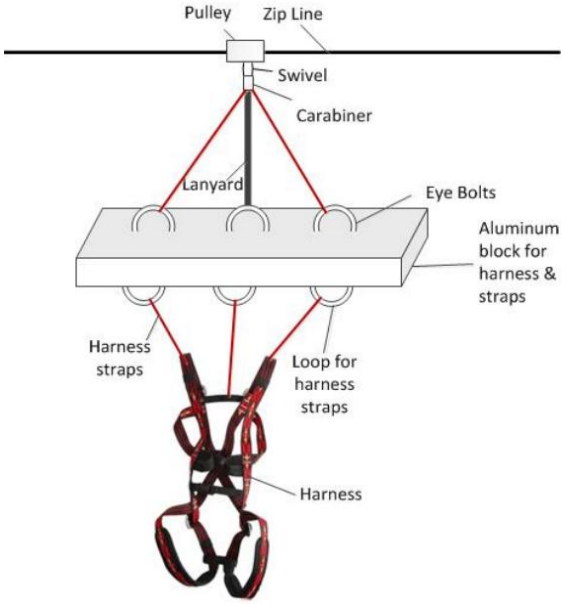


Figure 24: Visio Drawing of Harness Structure from Optimal Design

Figure 25: Actual Built Harness Structure

3.1.6: Harness

Elysa's parents requested that we found a harness that would provide minimal support as they do not want her to have so much support that she is constrained to limited movement. They want her to be able to have just enough support to keep her upright and to allow for maximum movement. The harness that we are using is kid's full body rock climbing harness, as shown in Figure 26, which is fully adjustable and also comes with leg padding.

Figure 26: Trango Junior Kids Rock Climbing Full Body Harness

2.3.1.7: Suspension

Bungee cords and straps will be used to connect the harness to the structure and to the pulley. Adjustable Bungee cords seen in Figure 27 are used to connect the harness structure to the swivel of the pulley via cable clamp.

Figure 27: Adjustable Bungee Cord

Figure 28: Strap with Buckle

To connect the harness to the u-bolts on the block, two 60" buckle straps, shown in Figure 28, will be used. These will be connected to the harness via carabiners that are placed on the shoulders straps and on the back. Using the longer straps will allow room for adjustments as Elysa grows.

Adaptive Skiing Device

3.2.1 Back support structure

The frame of the structure is made of two 20 mm diameter aluminum tubes and two 25 mm diameter aluminum tubes; they form two telescoping tubes so that the height is adjustable. The back support fabric is made of outdoor canvas with Velcro so it is also removable and can adjust position. Pictures are shown below in Figure 29.

Figure 29: Canvas for Back Support

Two supporting aluminum horizontal bars that are 25 mm diameter were welded between the telescoping tubes to keep the skis in parallel position, shown in Figure 30.

Figure 30: The supporting horizontal tubes for back support

3.2.2 Armrests

The frame of the structures is made of two 25 mm dia. aluminum tubes that form telescoping tubes with the armrests and one 25 mm dia. tube as the supporting horizontal tube that serve the same purpose as mentioned above, shown in Figure 31.

Figure 31: The supporting horizontal tube for armrests

3.2.3 The skis

The skis used for the device is the plastic skis made by Tike. It comes with bindings using straps since it is intended to be used by little kids, shown in Figure 32.

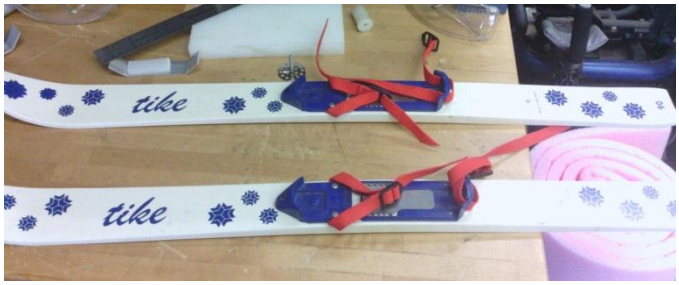


Figure 32: Plastic Skis

Two aluminum bars that are 2 ft in length, 2 in wide, and 5/16 in thick are used as the reinforcement to each ski to make them more rigid and stable. The design of the reinforced bars and the finished work is shown in Figure 32 and Figure 33, respectively. Two tubes were welded on the reinforced bars so that they can be inserted into the armrests and back support.

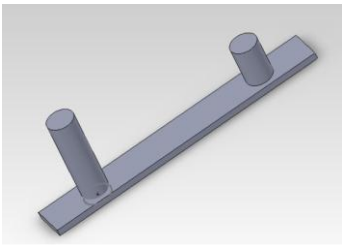


Figure 32: Design for the reinforced bars on skis

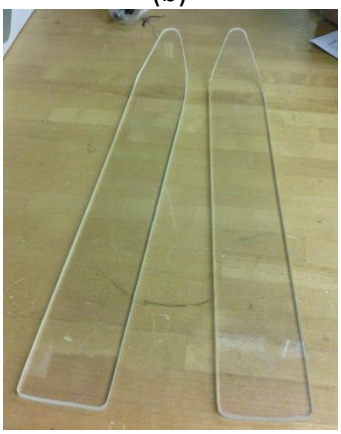
Figure 33: Finished reinforced bars on skis

3.2.4 Outriggers

The outriggers are each made with two 10 in. x 25 mm diameter aluminum tubes and welded perpendicular to each other, shown in Figure 34d. Each outriggers consists of a tube adapter (Figure 34a), and one Plexiglas ski (Figure 34b) and one reinforced bar (Figure 34c) for two outriggers.

(a)

(b)



(c)

(d)

Figure 34: (a) Tube Adaptor (b) Plexiglas Skis (c) Reinforcement Bar for Outrigger

The connection of the outriggers to the Plexiglas ski is shown in Figure 35. Tube adapter is inserted into the outriggers and screwed onto the Plexiglas with three ½ in #10 pan head screws. The finished outrigger is shown in Figure 8.

Figure 35: The connection of the outriggers on the Plexiglas skis

3.2.5 Corner braces

Four corner braces are used on the device, two 1” x 10” x 3/16” and two 1” x 8” x 3/16”. Each pair of the corner braces is bent to the same angle so that it can provide support to the armrests and back support. One end of the corner brace is welded to the main structure and the other end is screwed in the reinforcement bars and skis using 1 in. #10 pan headed screws. The corner brace is shown in Figure 36.

Figure 36: Corner Brace

3.4 Saddle Eating Chair

Base frame is made from 2”x2” aluminum square tubing. The front is the widest section it is 16 ½” the middle piece is 15” and the back is 14 1/2”. It is pictured below

Four locking caster wheels are on the base. As well as 2 semicircular discs made of 1/8” aluminum sheet metal. A small plastic piece was attached underneath the seat post so the post could slide easier and would not wear on the paint on the base. The caster wheels were attached by drilling 4 holes and attaching it using nuts and bolts. The four holes previously drilled in the caster wheels as shown below provide easy attachment to the base.

The caster wheel and mount place the base 2 inches off the ground.

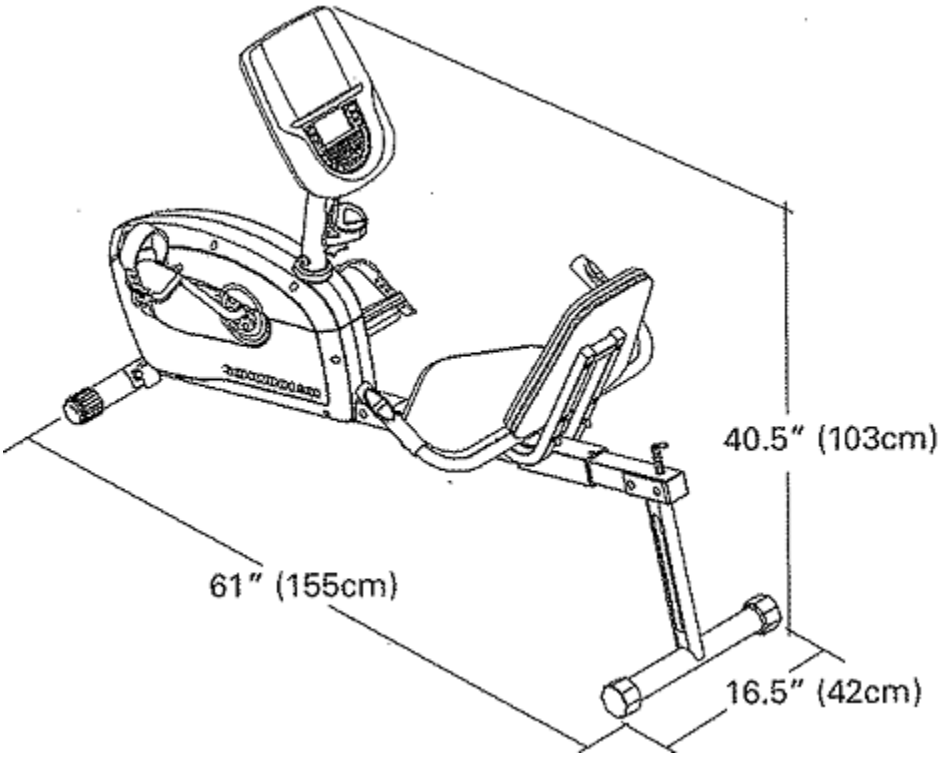
The telescoping tubing section is made from 2”x2” square aluminum tubing. The inner tubes are 1 ½”x 1 ½”. Plastic shims are inside to ensure a snug fit.

The seat is a cruiser bicycle seat that is 11” wide.

The seat is attached to the seat post by a plate that was completely custom designed to fit underneath the seat. Custom parts were cut and welded to attach the back support of the chair to the seat as well as the seat post. You can see the three threaded pieces that were already part of the seat secured through the custom plate with bolts. The bottom of the circular tubing that supports the pads used for the back support can be seen as well.

Cushions from the machine shop were placed on the seat back and can be adjusted up or down. Straps were made to attach to the harness. All of these were shown in the step by step instructions section.

Stationary Bike



These are the technical measurements from the manual. The bike weighs sixty pounds. The front has wheels that allow for easy movements.

A back pad was added to this bike shown in our final design below. Also two inch thick plastic wedges were attached to the pedals to reduce the distance our client needs to reach the pedals. The harness attachments are shown as well to keep her firmly in place.

Water Bike

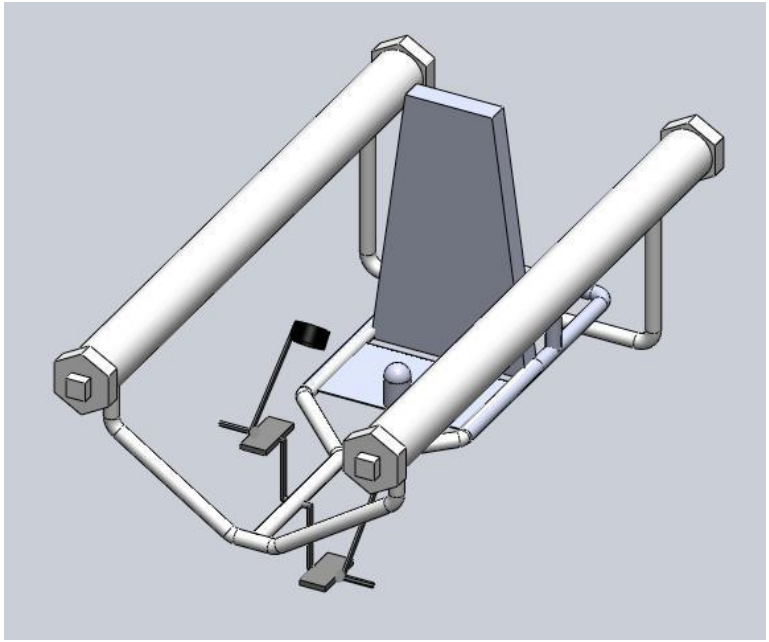


Figure 37: Solidworks picture of the Optimal Design

The technical description of this device is a simple analysis of is mechanical properties and a detailed layout of it physical dimension. There are not electronic components for this particular device therefore there will be no schematics for a circuit diagram.

3.5.1: "U" shaped side support tube

It is composed of three sections of 4 ½" hollow PVC tubes. The wall thickness is ¼" leaving and inner diameter of 4". The two side sections are 32" in length and the perpendicular back section in 18" in length. Each of these sections is wrapped in ¾" closed-cell polyurethane foam. This creates a total diameter of 5 ¼" for each support tube. The side and back support tubes are connected by 5" "L" shaped PVC elbow connectors. The open front end of the side tubes are sealed shut with 5" PVC caps to make the tubes water tight. The entire "U" support is the heaviest portion of the entire bike and weighs roughly 10 lbs.

3.5.2: Connecting frame

The frame is again built from PVC as well. The diameter of this section is 1 ½" with a thickness of 3/16" and an inner diameter of 1 ⅛". The connections between the two side barrels are 20" in length and are connected to the vertical connections via elbow PVC connectors. These vertical tubes extend upwards into the side barrel tubes and are roughly 10" in length. 4 ½" of these tubes are hidden inside the side tubes. This submerges the bottom of the frame roughly 6 ½" inches below the surface of the water. The center tube connects the front of the chair to the front of the frame and consists of two 6" tubes. The two tubes are connected using a straight connector. This is the area the pedals connect and is necessary for added durability. This tube is connected to the front of the frame with a "T" connector. The frame of the chair came prefabricated. The ends were cut and attach directly to the PVC frame. The frame is the lightest portion of the frame weighing about 2 ½" lbs.

3.5.3: Chair

The chair itself is height adjustable and the back is connected via two screws in a metal sheet with adjustable slots, as seen in Figure 38. The height of the back support is 16" which is more than enough for Elysa. The chair has two shoulder straps that can be used to strap Elysa into place. The base of the chair is a 11" wide by 11" deep section of mesh. The mesh wraps right around the PVC frame. The pommel sits in the middle front of the seat and extends upward 4 ½". The chair portion of this bike weighs approximately 6 lbs.

Figure 38: Water Bike Chair

3.5.4: Pedals

The bike pedals are the most complex part of this device and can be seen in Figure 39 below. The pedal frame is made from ¾" PVC tubing and has a thickness of ⅛". The pedals are 5" in length with a total length of 9 inches combined. This will provide an ample rotation radius for Elysa's pedaling motion. The hole the pedals go through is slightly larger than the diameter of the pedal tube and is buffered with a section of soft Velcro. This allows for a smooth yet stable rotation of the pedals. The actual pedals are attached using a three inch aluminum pin. This allows the pedals to spin freely as the unit rotates. Pedals are 3" wide and 2 ½" long, which will fit Elysa's feet nicely. The straps are made from heavy duty Velcro that will prevent Elysa's feet from coming loose during use. The pedals add no substantial weight to the bike bringing the total weight up to 18 ½ lbs.

Figure 39: Pedals with Velcro Straps

4. Troubleshooting

As a team, we hope that nothing bad occurs while the devices are in operation and we do not anticipate it happening in the future. However, it is important to recognize potential problems so that if something does happen they can be addressed accordingly. This section will briefly mention several troubleshooting techniques.

Zip Line Walking Device

4.1.1 Carabiner is found to be damaged

Retire the carabiner(s) and purchase new ones. All of the carabiners that are being used for this device are simple climbing carabiners, which can be found in any sports goods store, such as Sports Authority, EMS, Dicks, etc.

4.1.2 Friction on the wheels and/or strut channel is making the device difficult to use

Add some lubrication to the areas where the friction is occurring. WD-40 is a temporary solution as it is a solvent, not a lubricant. While it would help in the short run, during the long run, an actual lubricant would be better

4.1.3 Zip line has a crack or some other type of defect

Discontinue use and purchase a new one. The original one was found at a hardware store, so if a new one has to be purchased, any local hardware store should have it. Just bring a piece of it to the store, just to make sure that a proper replacement is purchased

4.1.4 Harness has a crack or some other type of defect

Refer to 4.1.3

4.1.5 Loose screws

Tighten them with a wrench or screwdriver, depending on the type of screw. If the screw is not tightening at all, such as if the thread was worn out, buy a replacement.

4.1.6 Signs of wear or cracked bungee cord

If the sign of wear is near the ends, then it is possible to cut the affected section and melt the ends to prevent further fraying. Otherwise, stop using it and purchase new ones. The ones that were purchased for this device are called Knotbone Adjustable Bungee Cords by NiteIze from EMS. Check the local sports stores in the area and if it cannot be found in any of them, they can be purchased from the manufacturer's site or from EMS, where we bought them.

Adaptive Skiing Device

4.2.1 The aluminum structure

If there are scratches or chipped paint found on the aluminum structure, it is recommended to repaint the damaged part of the structure to prevent corrosion or rust. If the dents were found on the aluminum structures, depends on the size of it, it may or may not need to be replaced. Dents might affect the sliding ability off the telescoping tubes and might cause the structure to bend easily, if dents were affecting the function ability, the structure has to be replaced as soon as possible for safety concern.

4.2.2 The outdoor canvas

One of the problems that might have been found on the outdoor canvas is the loosening Velcro. If the Velcro is found loose, it has to be sewing back before using it to ensure the safety of the rider. If the Velcro itself doesn't work properly, it has to be replaced as soon as possible

and the device is not to be used until the Velcro is fixed. If rips were found on the outdoor canvas, it has to be replaced before the next use.

4.2.3 The arm rests

Problems that might be found on the armrests are the molded soft pad, the dysfunction of the Velcro, and loosed screws. If the sponge of the soft padding is found to be molded, it has to be replaced with a new one as soon as possible; otherwise it might cause sickness to the rider. If the Velcro does not function properly, it is suggested to get a new one before the next use. If the screws are found loosen, screw it tight with the screwdriver. If the screws were found rusted, replace with the new ones as soon as possible, and the device is not to be used until the rusted screws are replaced.

4.2.4 The outriggers

If cracks were found on the Plexiglas skis, do not operate the device until it is replaced with the new one. If the cracks were found on the welds, send the device in for professional weld and the device should not be used until the new weld is done. Rusted tube adapter or base studs have to be replaced as soon as possible.

4.3 Saddle Eating Chair

Straps, clips, carabiners:

If any of these parts tear rip or accrue significant damage that impairs function replace them.

Telescoping tubing:

If the tubing does not slide easily any more: Apply some silicone lubricant and check to see nothing is caught between the tubing pieces. Make sure the inner plastic shims are still firmly attached to the tubing. If the plastic shims break bring them in to get repaired. If the seat post no longer tilts easily check to see nothing is caught underneath. Try and make sure the wing nut is at the appropriate tightness. If the wing nut is too tight it can cause the semi-circular pieces to hold the post too tight.

Wheels:

If the wheels are stuck make sure they are not in the locked position. If they no longer roll well try adding lubricant or replace them if necessary.

4.4 Stationary Bike

Console: if the bike does not turn on make sure the batteries are new and do not require replacement.

LED light: make sure the wire is attached well to the light bulb socket and there are no shorts. Make sure the wire is not damaged in anyway. If all the attachments are in order the light bulb will need to be replaced.

Track: If the seat does not slide easily on the track anymore apply silicone lubricant.

Water Bike

4.5.1 Loose Parts

With repeated use of the device there is a chance some of the tubing could come loose. This will become apparent when bubbles float to the surface from a connecting point on the bike. If this occurs it is necessary to apply a fresh coat of rubber cement to the area in question. A rubber cement, like the one pictured in Figure 39, will be supplied to the Carlson family for just such occasions. Make sure you are in an open area with proper ventilation. Make sure the area of concern is both clean and dry. Shake the can before use, and simple use the brush to apply a generous coat to the desired area. Allow 15 minutes for the area to dry before moving and allow 2 hours for the cement to set before putting back in the pool.

Oatey
No. 31013
REGULAR • CLEAR
PVC CEMENT
CEMENTO DE PVC COMÚN • TRANSPARENTE
DANGER:/PELIGRO:
EXTREMELY FLAMMABLE • HARMFUL OR FATAL IF SWALLOWED • VAPOR HARMFUL • EYE AND SKIN IRRITANT • MAY BE ABSORBED THROUGH SKIN • VAPORS MAY CAUSE FLASH FIRES
EXTREMADAMENTE INFLAMABLE • NOCIVO O FATAL SI SE INGIERE • VAPORES NOCIVOS • PUEDE IRRITAR LOS OJOS Y LA PIEL • PUEDE SER ABSORBIDO A TRAVÉS DE LA PIEL • LOS VAPORES PUEDEN CAUSAR INCENDIOS
MADE IN USA
8 fl. oz. (1/2 Pt.)
237 ml
HECHO EN E.U.

Figure 39: Rubber Cement

4.5.2 Part Cracks or Breaks

If a piece cracks or breaks do not try and use cement to fill crack. The cement is meant to connect pieces not fill holes. If this occurs the entire piece needs to be replaced. As stated before the entire frame of the bike what built from PVC and can be purchased at any local hardware store. The pieces easily fit into one another and they can be cut to size at the hardware store. At this point the cement can be used to connect the new and old parts as specified in the previous paragraph. It should be noted if it is a section of PVC with expandable foam on it that needs to be replaced we should be contacted to supply a new portion of the Pourable expandable foam and the problem should not be fixed without proper materials.

4.5.3 Mildew or Mold

If mildew or other types of bacteria begin to grow on the surface of the bike due to improper cleaning and/or storage it immediately needs to be removed. This could contaminate the pool and cause Elysa to get sick. The bacteria should be removed by using a disinfectant or antibacterial cleaner specified for this use. The best way to prevent this from occurring is to make sure the bike is clean and dry after each use and before storage.

4.5.4 Defects

It is important to remember that if there are any defects with the water bike it should not be used with Elysa in it. The bike is supporting Elysa and it would be unsafe for her if the bike began to float.

4.5.5 Repairs

All repairs should be completely tested before Elysa has a chance to use the bike once again. As mentioned earlier in the introduction. Elysa should never use this bike without the supervision of an adult. This bike offers Elysa the opportunity for a fun form of physical therapy but does add a level of risk. When the bike is used properly Elysa is at no risk at all but if used improperly it could be dangerous for Elysa. For this reason it is important she is always supervised when in the pool and recommended and adult be no more than an arm’s length away.

References:

[1] Tango User Manual for Tango Harness
[2] Black Diamond Carabiner User Manual
[3] http://www.niteize.com/products/knotbone-adjustable-bungee